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10/605,513	10/05/2003	Chen Ou	KYCP0011USA	2512

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EXAMINER	
MONDT, JOHANNES P	
ART UNIT	**PAPER NUMBER**
3663	

DATE MAILED: 03/31/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 10/605,513	Applicant(s) OU ET AL.	
	Examiner Johannes P. Mondt	Art Unit 3663	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 26 January 2006.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-11 and 19-21 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-11 and 19-21 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date 2/10/06.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

Response with Remarks filed 1/26/06 including arguments in traverse of the rejections made in the previous office action mailed 11/4/05 (first action on the merits after RCE filed 10/3/05) forms the basis for this office action. Claims 1-11 and 19-21 are in the application. Comments on said Remarks are included below under "Response to Arguments".

Information Disclosure Statement

The examiner has considered the items listed in the Information Disclosure Statement filed 2/10/06. A signed copy of Form PTO-1449 is herewith enclosed. Examiner stresses that only the English abstracts have been considered, which is indicated on the annotated PTO-1449.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

1. ***Claims 1-4, 10-11 and 19-21*** are rejected under 35 U.S.C. 103(a) as being unpatentable over Ming-Jiunn et al (6,078,064) in view of Seaford et al (2003/0201460 A1).

On claims 1 and 19: Ming-Jiunn et al teach (title, abstract, Figure 2 and col. 2, l. 27 – col. 3, l. 52) a nitride based light emitting diode (LED) comprising: a substrate 18

(col. 1, l. 33 and Figure 2), a light emitting stacked structure formed 13/14/15/16 (col. 1, l. 30-41) over the substrate; a nitride based heavily doped GaN or AlGaN or InGaN or InAlGaN (see col. 2, l. 50-60; hence meeting the limitation on material constitution on line 2 of claim 19) contact layer 12A (col. 2, l. 50-55) formed over the light emitting stacked structure; and a transparent conductive oxide layer 11B (col. 2, l. 53-56) formed over the nitride based heavily doped contact layer 12A.(Figure 2).

Ming-Jiunn et al do not necessarily teach the limitation that the heavily doped contact layer 12A to be a "dual dopant" contact layer, i.e., to comprise at least a p-type dopant and an n-type dopant and a material of the p-type dopant being different from a material of the n-type dopant. However, it would have been obvious to include said limitation in view of Seaford et al, who, in a patent on heavily doped semiconductor layers and in particular heavily doped III-V semiconductor layers (see title, abstract, Field of Invention, [0001], and "Background of the Invention", [0002]), - hence analogous art, teach the use of combined dopants, i.e., more than one dopant, to eliminate the detrimental effects created by increasing the dopant concentration of any single impurity beyond the concentration above which said dopant concentration starts having detrimental effects through diffusion (see Seaford et al, [0005]-[0009]), and teach in particular the doping with both Be (beryllium) and C (carbon) (as any Group IV element inherently both a p-type and an n-type dopant in any III-V semiconductor, with reference to Fukuda et al, page 12, as made of record in office action of 6/3/05; see page 6; see item U on the PTO-892 Form with said office action) of any heavily doped III-V layer, thus in particular also the GaN layer by Ming-Jiunn et al, which, being a

heavily doped contact layer (12A) necessarily requires high dopant concentration (thus also meeting dependent claim 19).

Motivation to include the teaching by Seaford et al in the invention by Ming-Jiunn et al immediately derives from the stated avoidance of deleterious diffusion effects on heavily doped III-V compound semiconductor layers by Seaford et al ([0005]-[0009]) that directly applies to the necessarily heavily doped contact layer 12A by Ming-Jiunn et al, said layer serving to provide electrical contact to the Ni/Au electrode (see Ming-Jiunn et al, col. 1, l. 38) so as to reduce the voltage drop across the contact (what is called contact resistance) (col. 2, l. 55-56).

On claim 2: in the combined invention the nitride based contact layer 12A is made of $Al_aIn_bGa_{1-(a+b)}N$ with a, b, and a+b in between 0 and 1 (inclusive end points (col. 2, l. 55-60; any AlGaInN stoichiometric composition can be thus formulated), and the transparent conductive oxide is made of tin-indium-oxide (ITO) (col. 2, l. 30).

On claims 3 and 4: the further limitation as defined by claims 3 and 4 each *fail to further limit the structure as claimed*, as opposed to the method of making of the structure, and hence fail to distinguish over the prior art, given a single layer is claimed. Parenthetically, Seaford et al do teach said nitride based dual dopant contact layer is formed by adding the p-type dopants and n-type dopants together through epitaxial growth (in particular: MBE) (see [0021]-[0022]), thus meeting, in the combined invention, claim 3.

On claim 10 and 11: Ming-Jiunn et al also teach said substrate to be a conductive (in particular, of first conductivity type) substrate selected out of the group SiC, GaAs and Si, hence meeting claims 10 and 11.

On claims 20 and 21: Ming-Jiunn et al teach (title, abstract, Figure 2 and col. 2, l. 27 – col. 3, l. 52) a nitride based light emitting diode (LED) comprising: a substrate 18 (col. 1, l. 33 and Figure 2), a light emitting stacked structure formed 13/14/15/16 (col. 1, l. 30-41) over the substrate; a nitride based heavily doped GaN or AlGaN or InGaN or InAlGaN (see col. 2, l. 50-60; hence meeting the limitation on material constitution on line 6 of claim 20) contact layer 12A (col. 2, l. 50-55) formed over the light emitting stacked structure; and a transparent conductive oxide layer 11B (col. 2, l. 53-56) formed over the nitride based heavily doped contact layer 12A.(Figure 2).

Ming-Jiunn et al do not necessarily teach the limitation that the heavily doped contact layer 12A to be a "dual dopant" contact layer, i.e., to comprise at least a p-type dopant and an n-type dopant and a material of the p-type dopant being different from a material of the n-type dopant.

However, it would have been obvious to include said limitation in view of Seaford et al, who, in a patent on heavily doped semiconductor layers and in particular heavily doped III-V semiconductor layers (see title, abstract, Field of Invention, [0001], and "Background of the Invention", [0002]), - hence analogous art, teach the use of combined dopants, i.e., more than one dopant, to eliminate the detrimental effects created by increasing the dopant concentration of any single impurity beyond the concentration above which said dopant concentration starts having detrimental effects

through diffusion (see Seaford et al, [0005]-[0009]), and teach in particular the doping with both Be (beryllium) and C (carbon) of any heavily doped III-V layer, thus in particular also the GaN layer by Ming-Jiunn et al, which, being a heavily doped contact layer (12A) necessarily requires high dopant concentration; by which material selection of the p-type and n-type dopants the limitation additional to claim 20 in claim 21 isd also met.

Motivation to include the teaching by Seaford et al in the invention by Ming-Jiunn et al immediately derives from the stated avoidance of deleterious diffusion effects on heavily doped III-V compound semiconductor layers by Seaford et al ([0005]-[0009]) that directly applies to the necessarily heavily doped contact layer 12A by Ming-Jiunn et al, said layer serving to provide electrical contact to the Ni/Au electrode (see Ming-Jiunn et al, col. 1, l. 38) so as to reduce the voltage drop across the contact (what is called contact resistance) (col. 2, l. 55-56).

2. ***Claims 5-9*** are rejected under 35 U.S.C. 103(a) as being unpatentable over Ming-Jiunn et al and Seaford et al as applied to claim 1 above, and further in view of Asai et al (6,554,896 B1) and Tanizawa et al (6,657,234 B1).

On claims 5 and 7: the substrate is an insulating substrate (sapphire; see Ming-Jiunn et al, col. 1, l. 32), the light emitting stacked structure comprising: a first conductivity type (n-type) contact layer 16 (col. 2, l. 50-60 and Figure 2) formed over the substrate and made of n-GaN (col. 1, l. 40) (said n-GaN serves to provide contact to electrode 19 and hence is a contact layer (col. 1, l. 40-41)), hence meeting the limitation

on material constitution in lines 5-6; a light emitting layer 14 (col. 1, l. 35) formed over the first conductivity type nitride based contact layer 16; and a second conductivity type (p-type) contact layer 12 (col. 2, l. 50-60) formed over the light emitting layer 14 and made of AlInGaN and hence meeting the material constitution claimed in lines 10-11 of claim 5.

Ming-Jiunn et al do not necessarily teach (a) a buffer layer formed over said insulating substrate; nor (b) that the light emitting layer is a multiple quantum well.

However, ad (a) it would have been obvious to include the limitation on buffer layer in view of Asai et al, who teach to insert a buffer layer 13 between a sapphire substrate 11 and a AlGaInN layer 42 (end points of the stoichiometric parameters including the binary compounds) of a light emitting stack structure of a light emitting diode so as to improve crystallinity (col. 2, l. 56-59). *Motivation* to include the teaching by Asai et al in this regard is the lattice mismatch between sapphire substrate 18 and n-GaN contact layer 16 also existing in Ming-Jiunn et al while improving crystallinity leads to improved light efficiency because crystal defects absorb light.

Furthermore, ad (b), it would have been obvious to include the limitation on multiple quantum well light emitting layer in view of Tanizawa et al, who, in a patent on a nitride based light emitting diode (LED), hence analogous art, teaches for the specific purpose of lowering operational voltage and increasing emitting output (abstract) that the multiple quantum well has r (e.g., 15 (Example 1)) InGaN quantum wells and (r+1) InGaN barriers, each InGaN quantum well sandwiched in between two InGaN barriers (col. 7, l. 1-14 and col. 14, l. 19-28, i.e., claim 5 in Tanizawa), each InGaN quantum well

fabricated by $In_eGa_{1-e}N$ and each InGaN barrier is made of $In_fGa_{1-f}N$, $r \geq 1$, and $0 \leq f < e \leq 1$ (in particular in Example 1: e=0.3 and f=0; see, however, also the other examples, col. 3, l. 50-55 and col. 4, l. 59-65) for other values of these parameters). Thereby, claim 7 is also seen to be met..

Motivation to include the teaching by Tanizawa in the invention by Ming-Jiunn et al derives from the knowledge common in the semiconductor light emitting diode art that it takes two barriers to define a well: see, e.g., M. Fukuda, "Optical Semiconductor Devices", Wily Series in Microwave and Optical Engineering, John Wiley and Sons, New York (1999), pages 82-85.

On claim 6: the insulating substrate is made of sapphire (col. 1, l. 32 and Figure 2).

On claim 8: the LED by Ming-Jiunn et al further comprises a first conductivity type (n-type) cladding layer 15 (col. 1, l. 35 and Figure 2) interposed between the first conductivity type contact layer 16 and the multiple quantum well light emitting layer 14, and the first conductivity type cladding layer is made of AlGaN hence the limitation on material constitution in line 4 of claim 8 is also met.

On claim 9: the LED by Ming-Jiunn et al further comprises a second conductivity type cladding layer 13 (col. 1, l. 35 and Figure 2) interposed between the second conductivity type contact layer 12 and the multiple quantum well light emitting layer 14 and made of AlGaN (loc.cit.), hence the limitation on material constitution in line 4 of claim 9 is also met.

Response to Arguments

Applicant's arguments filed 1/26/06 have been fully considered but they are not persuasive. Inherently, C, being a Group IV element is amphoteric, i.e., C is both n-type and p-type dopant, in a Group III-V semiconductor, such as GaAs, as examiner has previously pointed out (see Final Action mailed 6/3/05, page 6, with reference to Fukuda previously made of record). Hence, while Be is a p-type dopant, C is an n-type dopant (in addition to a p-type dopant), which meets the claim language "at least one p-type dopant and an n-type dopant, and a material of the p-type dopant being different from a material of the n-type dopant".

To address the specific argument in traverse by applicant: Seaford does not contradict the above: impurities Be and C are "of the same carrier type", namely p-type, but they also are of opposite carrier type (Be being p-type and C being n-type). Therefore, the first paragraph on page 2 of Remarks contains a true statement that, however, does not refute the rejection because C is both n-type dopant and p-type dopant.

The second paragraph on page 2 of Remarks appears to merely confirm examiner's position in this regard.

With regard to the traverse on the basis of motivation, applicant's allegation that one skilled in the art would not find it obvious to take Seaford's teachings about dopants and apply it to Ming-Jiunn's nitride based layer since the doping properties are completely different" is not persuasive, because C impurities occupy both III and V sites and as such are not completely different from Be impurities as the latter occupy V sites, while, whether overall more III sites than V sites or more V sites than III sites are

occupied by C impurities depends on the conditions during the introduction of the C impurities (low or high temperature, with reference once more to Fukuda, loc.cit.) and does not in any way detract from the correctness of the statement that while C may under circumstances occupy more V sites than III sites, C still is an n-dopant, in addition to being a p-dopant. Note that both a high temperature and a low temperature method of doping are included in Ming-Jiunn et al (see col. 2, l. 50-54), namely (thermal) diffusion and ion implantation, respectively. Hence while C doping overall tends to increase the number of holes when ion-implanted it still is, inter alia, an n-dopant, which is relevant for the claim language.

The rejections of the previous office action therefore stand.

Conclusion

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Johannes P. Mondt whose telephone number is 571-272-1919. The examiner can normally be reached on 8:00 - 18:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jack W. Keith can be reached on 571-272-6878. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

JPM
March 29, 2006

Deandra Hughes
DEANDRA M. HUGHES
PRIMARY PATENT EXAMINER